DO STROMATOLITES NEED TIDES TO TRAP OOIDS? INSIGHTS FROM THE COASTAL-LAKE CARBONATES OF THE LEZA FM (EARLY CRETACEOUS, N SPAIN)

Pablo SUAREZ-GONZALEZ, I. Emma QUIJADA, M. Isabel BENITO, Ramón MAS

DPTO. ESTRATIGRAFIA, FACULTAD DE CIENCIAS GEOLOGICAS, UNIVERSIDAD COMPLUTENSE DE MADRID - IGEO (CSIC-UCM), José Antonio Nováis 12., 28040, Madrid, Spain, pablosuarez@geo.ucm.es

Stromatolites associated with ooid grainstones are often described in the literature, both in marine and fresh-water environments. However, lateral relationship between them does not necessary entail that ooids are trapped within the stromatolites. Interestingly, stromatolites that trap ooids are quite rare. The Cretaceous Leza Fm (Barremian-Aptian in age, Cameros Basin, N. Spain) offers an exceptional opportunity to elucidate the factors controlling grain trapping. The Leza Fm carbonates were deposited in coastal-lakes with several interrelated sedimentary environments, including fresh-water facies and facies with clear marine influence, and it contains two stromatolite types associated with ooids: one type traps grains (agglutinated oolitic stromatolites) and the other (skeletal stromatolites) does not.

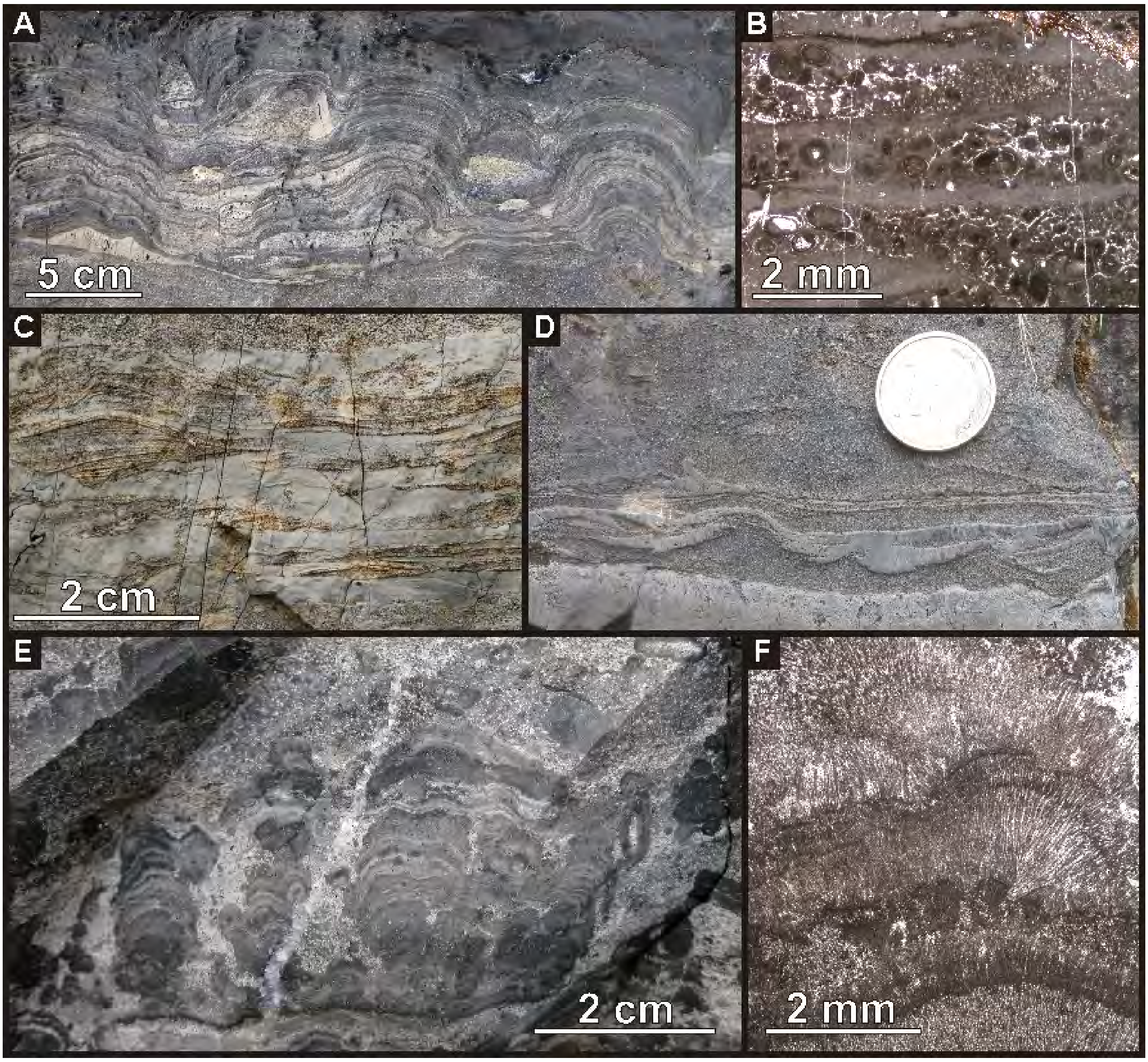
Agglutinated oolitic stromatolites of the Leza Fm (Fig. 1A) occur at the top of rippled ooid grainstone deposits, up to 1 m thick. Ooid grainstones are composed of ooids, peloids, intraclasts and bioclasts (ostracodes and foraminifera) and they show cm-scale lenticular, wavy and flaser bedding (Fig. 1C-D), which resemble some of the typical structures of peritidal carbonates. The agglutinated oolitic stromatolites are composed of alternating oolitic layers (formed by trapping of ooids by microbial mats) and clotted-peloidal micritic layers (formed by microbially-induced carbonate precipitation) (Fig. 1B). Small calcified filaments, relicts of mat microbes, are very rare. These stromatolites are one of the oldest examples of agglutinated carbonate stromatolites and their oolitic layers are similar to those of present-day popular examples of Bahamas and Shark Bay (Australia) (Reid et al., 1995). Nevertheless, the present-day agglutinated oolitic stromatolites are formed mainly by one accretion mechanism (trapping of ooids) with hiatuses marked by thin micritic crusts, but they do not significantly accrete by precipitating microbially-induced clotted-peloidal or filamentous carbonate. The conditions for effectively trapping ooids in these recent examples are soft and partially uncalcified surface mats, explained by the low carbonate saturation state of the waters (Riding, 2011), and grains supply, explained by the movement of ooids over the stromatolites due to tidal currents (Dill et al., 1986). Shallow marine settings, generally showing tidal influence, have been proposed for the rare ancient examples of these stromatolites (Riding et al., 1991; Matyskiewicz et al., 2006; Arenas & Pomar, 2010).

Skeletal stromatolites of the Leza Fm (Fig. 1E) occur in fresh-water lacustrine facies, where they are laterally related with sandstones and grainstones of intraclasts, oncoids, ooids and bioclasts (ostracodes and charophytes). The dominant microfabric of these examples is long and strongly calcified microbial filaments with no trapped grains (Fig. 1F), thus their main accretion mechanism is active microbial mat calcification. Several examples of skeletal stromatolites and other stromatolite types are associated with ooid grainstones in ancient lacustrine sequences (e.g. Cole & Picard, 1978; Paul & Peryt, 2000), but, to our knowledge, none of them have trapped ooids in their microfabrics.

The textural differences between the Leza Fm tidal-influenced agglutinated oolitic stromatolites (with soft and poorly calcified mats that trapped grains, Figs. 1A-B) and fresh-water skeletal stromatolites (with hard and strongly calcified mats that did not trap grains, Figs. 1E-F), suggests that water chemistry and hydrodynamics during their formation were different. Carbonate saturation state of marine water might have been low enough to prevent intense microbial calcification in the tidal-influenced coastal-lakes, producing soft mats that trapped grains. In addition, the cyclic hydrodynamic changes produced by tides allowed periodic supply of grains to be trapped by the soft mats, producing agglutinated ooid stromatolites. In contrast, the higher carbonate saturation of meteoric waters, which came from the Jurassic carbonate substrate of the Cameros Basin, as well as the lower hydrodynamic changes of lacustrine environments, probably lead to the stronger mat calcification of skeletal stromatolites of the Leza Fm and the absence of trapped grains.

Furthermore, input of meteoric water in the tidal-influenced coastal-lakes of the Leza Fm would explain the differences between the present-day agglutinated oolitic stromatolites (formed mainly by trapping), and the Leza agglutinated examples (formed by alternation of trapping and mat calcification).

To conclude, we propose that water chemistry and hydrodynamics of tidal-influenced environments are very suitable for the development of agglutinated carbonate stromatolites, explaining why these stromatolites are almost restricted to tidal environments at the present-day and in the geological record.



Field (A, C, D, E) and microscope (B, F) images of the Leza Fm stromatolites and associated facies. See text for descriptions.

Arenas, C. & Pomar, L. (2010) Palaeog., Palaeocl., Palaeoec., 297, 465-485.
Cole, R. & Picard, M. (1978) Geological Society of America Bulletin, 89, 1441-1454.
Dill, R.F.; Shinn, E.A.; Jones, A.T.; Kelly, K. & Steinen, R.P. (1986) Nature, 324, 55-58.
Matyszkiewicz, J.; Krajewski, M. and Kedzierski, J. (2006) Facies, 52, 249-263.
Paul, J. & Peryt, T.M. (2000) Palaeog., Palaeocl., Palaeoec., 161, 435-458.
Reid, P.; Macintyre, I.; Browne, K.; Steneck, R. & Miller, T. (1995) Facies, 33, 1-18.
Riding, R. (2011) In: Reitner & Thiel (eds.), Encyclopedia of Geobiology, 635-654.
Riding, R.; Braga, J.C. & Martín, J.M. (1991) Sedimentary Geology, 71, 121-127.

TIDALITES 2012

Caen, France
July 31 - August 2

Abstracts